

Article

Adaptation to Climate Change Across Local Policies: An Investigation in Six Italian Cities

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Abstract: Climate change is a concerning phenomenon worldwide. The reduction in greenhouse gas emissions is the core of the mitigation strategies that are effective countermeasures to address a changing climate in the long term. Nevertheless, the need for short-term solutions regarding adaptation to climate change (ACC) has gained growing interest in the scientific community and in European institutions. European and national ACC principles are being integrated in strategies and plans. In Italy, some regions have adopted ACC principles in strategic plans, which influence the whole local planning system and persuade local communities to become more climate-resilient. This study focuses on the mainstreaming of ACC into strategies, plans, programs, and projects (SPPPs) adopted by the following Italian cities: Bologna, Milan, Naples, Rome, Turin, and Venice. We scrutinize the contents of SPPPs with respect to four criteria: (i) references to strategies or plans for ACC; (ii) inclusion of ACC objectives and (iii) measures; and (iv) references to—or the inclusion of—climatic analysis on historical series and/or future projections. We found out that most SPPPs adopted by the cities have considered ACC in a promising way, i.e., all the cities are inclined to promote ACC, despite three of them lacking a municipal ACC strategy or plan and a National Adaptation Plan not being in force.

Keywords: adaptation to climate change; local scale; Italian cities; strategies, plans, programs, and projects; assessment criteria; mainstreaming



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1. Introduction

Climate change is an increasingly alarming phenomenon [1–3]. As a major countermeasure, the promotion of mitigation initiatives aimed at reducing greenhouse gas emissions is remarkable [4–6], although it is insufficient as “further temperature increase is unavoidable” [2]. Mitigation strategies are likely to have effects in the long-term, but the protection and well-being of human settlements require effective short-term actions [7]. Therefore, adaptation to climate change (ACC) has gained a leading role as an approach aimed at achieving climate resilience using grey, green, and blue infrastructures, the enhancement of ecosystems’ connectivity, spatial planning tools, insurance tools, early warning systems, and further adaptation actions [8].

The European Union (EU) acknowledged the importance of adaptation by adopting in 2013 [9], and updating in 2021 [10], a specific EU Adaptation Strategy on ACC. The new release stresses the need to make the EU climate-resilient “by making adaptation smarter, more systemic, swifter, and by stepping up international action” [10]. According

to the European Commission [10], all Member States have adopted national strategies and/or plans for ACC (an overview of adopted national adaptation strategies and plans is available in: European Environment Agency [11]). The Italian National Strategy for ACC was adopted in 2015 [12], while the National Adaptation Plan is currently undergoing a strategic environmental assessment procedure [13]. Some Italian regions, such as Emilia-Romagna, Lombardy, and Sardinia, have adopted regional strategies for ACC [14], which set out a reference framework for regional and sub-regional planning and government tools (i.e., local strategies, plans, programs, and projects).

Strategic sub-regional spatial planning is crucial for the implementation of actions leading to ACC [15–17]. Municipalities translate European, national, and regional strategic guidance and policies into tangible grey and green measures. As Hurlimann et al. [17] warned, urban planning is expected to have “a significant influence on climate change actions [but] there has been limited analysis of the extent to which urban planning policy documents addresses climate change adaptation and or mitigation”. In addition, the scientific literature lacks studies that investigate the integration of ACC considerations in strategies, plans, programs, and projects (SPPPs) adopted by Italian cities. Thus, we aim to fill this research gap by investigating whether—and to what extent—ACC has been integrated into SPPPs adopted by the following six Italian cities: Bologna, Milan, Naples, Rome, Turin, and Venice. In other words, the research questions are: (i) can we apply the methodological approach proposed by De Montis et al. [18,19] and Ledda et al. [7,20] to provide an overview on the integration of ACC considerations at the subregional scale (RQ1)? (ii) After the publication of the national strategy for adaptation to climate change, how are some of the main Italian cities integrating ACC into the planning and management tools of their territory (RQ2)? To answer the RQs, we apply four criteria proposed by Ledda et al. [7,20], who focused on regional planning tools.

This paper is structured as follows. In Section 2, we provide the reader with an overview of previous studies that address the integration—i.e., the so-called mainstreaming—of ACC in different policy and planning tools by using criteria-based methodological approaches. In Section 3, we describe the methods (assessment criteria and evaluation system) and materials (SPPPs adopted—or released—by the cities) used. In Sections 4 and 5, respectively, we show and discuss the main findings. Finally, in Section 6, we respond the RQs and point out the main limitations of the research, and suggest new lines of research to overcome these limitations.

2. Methodological Approaches for Scrutinizing ACC in Institutional Tools: An Overview

Researchers have focused on ACC by considering several typologies of planning tools, including local ACC plans, action plans, urban plans, etc., and applying qualitative and/or quantitative approaches at the regional [7,18–20] and urban scale [15,17,21]. A recent study also considered the relationships between ACC and sustainable development [22], which are key factors to define the planning framework.

De Montis et al. [19] and Ledda et al. [7] focused on the governance of ACC at the regional scale. The authors proposed and applied a set of criteria to scrutinize regional plans adopted in Sardinia (Italy) and assessed to what extent ACC had been integrated. De Montis et al. [19] assessed if the plans (i) referred to ACC strategies and measures, and (ii) identified the responsible bodies for ACC tasks (criteria). Most plans did not refer to any ACC strategies, part of the plans defined implicit ACC measures, and all the plans identified responsible bodies for ACC tasks. Ledda et al. [7] proposed three criteria to scrutinize six plans: references to ACC strategies, the inclusion of explicit or implicit ACC measures, and the identification of responsible bodies for implementing explicit ACC measures. As a result, the plans included—also implicitly—ACC measures, while the responsible bodies were set in three plans that also referred to ACC strategies. De Montis et al. [18] and Ledda et al. [20] focused on the Strategic Environmental Assessment (SEA) report by applying criteria to assess the mainstreaming of ACC considerations into SEA reports of regional

plans adopted in Sardinia (Italy). The criteria were used to assess if the plans referred to ACC strategies and included climate analysis, adaptation objectives, and explicit or implicit ACC measures. Ledda et al. [20] summarized previous studies [23–26] to point out the fruitful use of criteria-based assessment frameworks to evaluate the consideration of climate change issues in SEA reports drafted for different type of plans. Baker et al. [21] assessed seven local ACC plans adopted in Southeast Queensland (Australia). The authors proposed and applied a quantitative approach rooted in an evaluation framework, which consisted of components, i.e., outcome criteria, evaluation categories, and “an enumeration system for coding qualitative information” [21]. The eight outcome criteria included water quantity and quality, (the impacts of) flooding, landscape structure, etc. In addition, the authors performed semi-structured interviews by involving local government representatives to acquire comments concerning the plan evaluation scores. Kumar and Geneletti [15] aimed at investigating how climate change issues were incorporated in spatial plans and considered fifty-nine local tools adopted by Indian cities. The plans were scrutinized against a set of forty criteria clustered in three components: ‘awareness’ (e.g., concept of climate change or global warming), ‘analysis’ (e.g., base year assessment of GHG emission), and ‘action’ (e.g., disaster-resistant land use and building code). Furthermore, a scoring system was adopted, in which a criterion was given a score ranging from 0 to 2 depending on how the criterion was identified in the plan (0: no evidence of the criterion; 1: criterion acknowledged but devoid of further details; 2: criterion acknowledged, and significant details considered in the plan). Hurlimann et al. [17] focused on the inclusion of ACC (and mitigation) in the context of urban planning by scrutinizing a set of documents adopted in Victoria, Australia through a quali-quantitative assessment approach. As a part of the research method, Hurlimann et al. [17] used a criteria-based evaluation (i.e., a Document Evaluation Matrix) focusing on mitigation, adaptation, and their integration. Adaptation criteria regarded ACC per se and sea level rise. Hurlimann et al. [17] stressed that both adaptation and mitigation should be better considered and integrated in urban planning documents.

3. Materials and Methods

In this section, we introduce the assessment criteria applied to assess the performance of the strategies, plans, programs, and projects (SPPPs) in terms of ACC contents, describe the evaluation system of the SPPPs, and provide an overview of the six cities selected as the case study.

3.1. Assessment Criteria and Evaluation System

We aimed at assessing whether the SPPPs (Table 1): (i) refer to international, European, national, or regional strategies, or plans of any level, for ACC (for example, the European strategy for adaptation to climate change, the Italian national strategy of adaptation to climate change); (ii) include—even implicit—ACC objectives and (iii) measures; and (iv) report on a climate analysis on historical series and/or future projections. Inspired by De Montis et al. [19], Ledda et al. [7], Ledda et al. [20], and Baker et al. [21], we used unweighted criteria, i.e., we assigned the criteria the same weight. We are aware of this potential limitation of the method.

Table 1. Strategies, plans, programs, and projects (SPPPs) assessment criteria (after [7,18–20]).

	Criteria	Description	References
1	Adaptation strategy or plan	SPPPs refer to strategies or plans for ACC.	[9,12,19,20]
2	Adaptation objectives	... define objectives aimed at promoting ACC. ... include explicit (specifically defined in response to climate change) or implicit (not specifically defined as a response to climate change, but useful for adaptation) adaptation measures.	[18,20,27,28]
3	Adaptation measures	... include climate analysis on historical series and/or future climate scenarios.	[7,9,12,19,29]
4	Climate analysis		[18,20,30,31]

We used a qualitative color-based approach to assess the SPPPs. Table 2 shows the evaluation system.

Table 2. Evaluation system of the SPPPs. Very dark blue is used when the criterion is explicitly fully met, soft yellow if it is implicitly—or partially—met, and white when the criterion is not met.

Legend	SPPPs Refer
	explicitly to one criterion
	implicitly—or partially—to one criterion
	to no criterion

The use of adequate colors is relevant to science communication [32,33]; thus, the fulfillment of the criteria is represented by using three colors that should be correctly interpreted by most people: very dark blue is used when the criterion is explicitly fully met, soft yellow if it is implicitly—or partially—met, and white when the criterion is not met. It should be noted that the performance of the tools does not enter the merits of the type of SPPPs considered: a resilience strategy or adaptation plan is obviously more likely to meet the four criteria than a strategy or plan drafted for other sectors.

3.2. Application to a Case Study: The Six Cities

The method was applied on SPPPs adopted by six Italian metropolitan cities: Bologna, Milan, Naples, Rome, Turin, and Venice (Figure 1 and Table 3). The cities were chosen according to three criteria: (i) the representativeness of different geographical contexts, (ii) vulnerability due to the size of the resident population that could be affected by climate change impacts, and (iii) the free online accessibility of the SPPPs.

Three experts in landscape and spatial planning, ACC, green infrastructure, and ecosystem services independently scrutinized the documents. These experts were involved in several meetings held between March and September 2021 and aimed at sharing and discussing the findings with colleagues working on the same project (see Funding). Only when the findings became clear to all the participants was a final report released.

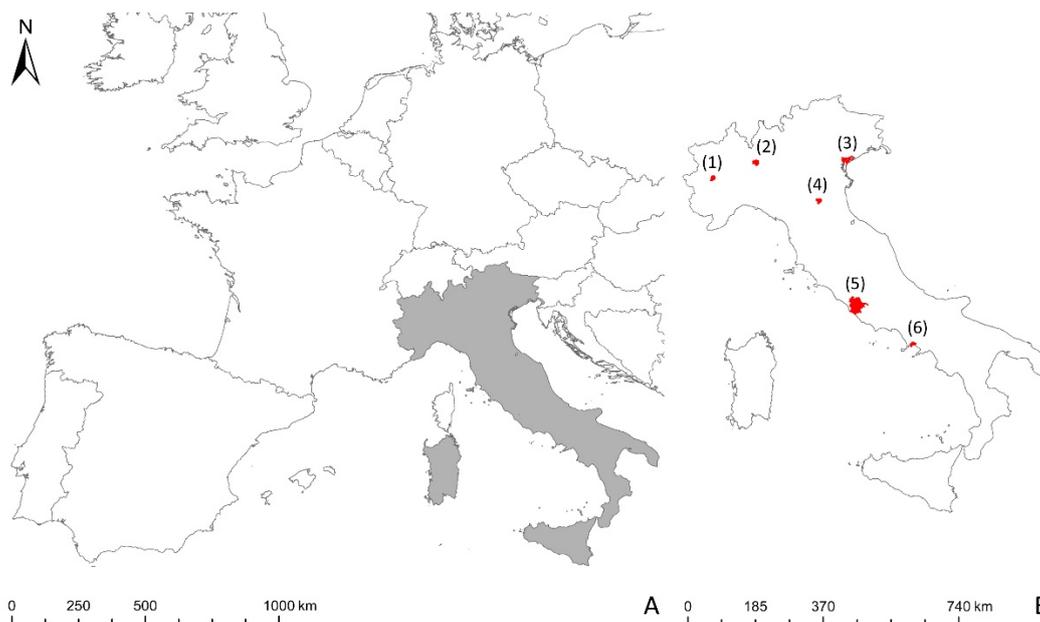


Figure 1. Geographical context. (A) in grey, Italy; (B) in red, the location of the six cities: (1) Turin, (2) Milan, (3) Venice, (4) Bologna, (5) Rome, and (6) Naples.

Table 3. The six cities, by resident population, surface area, ACC tool, approval year, and reference.

	City	Resident Population [34]	Surface Area [35]	ACC Strategy or Plan		
		Inhabitants	km ²	Type	Approval Year	Reference
1	Bologna	392,301	140.86	Plan	2015	City of Bologna [36]
2	Milan	1,372,219	181.67	-	-	-
3	Naples	915,220	118.94	-	-	-
4	Rome	2,763,559	1287.24	Strategy	2018	City of Rome [37]
5	Turin	850,435	130.06	Plan	2020	City of Turin [38]
6	Venice	254,833	415.89	-	-	-

Bologna is the regional capital of the Emilia-Romagna administrative region, Northeast Italy, a region overlooking the Adriatic Sea. Bologna hosts about 390,000 inhabitants. In 2015, the municipality adopted the Climate Change Adaptation Plan, which was drafted in the context of the LIFE project ‘Bologna Local Urban Environment Adaptation Plan for a Resilient City’. Rome is the capital of Italy and the regional capital of the Lazio administrative region, in the center of the Italian peninsula. Rome hosts about 2.7 million inhabitants. In 2018, the municipality adopted the Climate Resilience Strategy. Turin is the regional capital of Piedmont, Northwest Italy, a region bordering France. Turin hosts about 850,000 inhabitants. In 2020, the municipality adopted its Climate Resilience Plan. Milan (regional capital of the Lombardy, Northwest Italy), Naples (regional capital of Campania, center-south Italy) and Venice (regional capital of the region Veneto, Northeast Italy) have not adopted an ACC plan or strategy yet.

From February to May 2021, we invited officials, managers, and others to take part in the research. The persons involved included those who, directly or indirectly, could have been involved in the drafting, adoption, or approval of strategies, plans, programs, and projects developed for different sectors (including territorial planning, urban planning, environment, transport, public parks management). The contact details (e-mails and phone numbers) were retrieved from the institutional websites of the municipalities. The officials involved were explicitly asked if they were aware of any climate change adaptation initiatives—promoted by their own administration—in terms of strategies, plans, programs, and projects adopted—or approved. Based on their suggestions, we downloaded the documents to be scrutinized (see Table 4).

Table 4. Descriptive outline of the SPPPs selected for the scrutiny.

	City	Description	Source (Last Accessed: 15 June 2021)
1	Bologna	1.1 Bologna Local Urban Environment Adaptation Plan for a Resilient City (BLUEAP).	http://www.comune.bologna.it/ambiente/servizi/6:34902#
		1.2 Action Plan for Sustainable Energy and Climate [Piano di Azione per l'Energia Sostenibile ed il Clima].	http://www.comune.bologna.it/paesc
		1.3 Municipal master plan [Piano Urbanistico Generale].	http://dru.iperbole.bologna.it/pianificazione?filter=Piano%20Urbanistico%20Generale%20(PUG)
2	Milan	2.1 Municipal master plan [Piano di Governo del territorio].	https://www.comune.milano.it/aree-tematiche/urbanistica-ed-edilizia/pgt-approvato-e-vigente-milano-2030
		2.2 Air and Climate Plan [Piano Aria e Clima].	https://www.comune.milano.it/piano-aria-clima
		2.3 Clever Cities Project [Progetto Clever Cities].	https://www.comune.milano.it/aree-tematiche/relazioni-internazionali/progetti-ue/clever-cities
		2.4 ForestaMI Project [Progetto ForestaMI].	https://forestami.org/
		2.5 ClimaMI Project [Progetto ClimaMI].	https://www.progettoclimami.it
3	Naples	3.1 Action Plan for Sustainable Energy [Piano d'Azione per l'Energia Sostenibile].	https://www.comune.napoli.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/35107
		3.2 Preparatory Municipal Urban Plan [Preliminare del Piano Urbanistico Comunale].	https://www.comune.napoli.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/37912
		3.3 Spatial Coordination Plan of the Metropolitan City [Piano Territoriale di Coordinamento Città Metropolitana].	https://www.cittametropolitana.na.it/pianificazione_territoriale/ptcp
		3.4 CLARITY project [Progetto CLARITY].	https://cordis.europa.eu/project/id/730355/it https://cordis.europa.eu/article/id/422466-screening-tools-to-help-eu-planners-to-support-climate-change-adaptation-decisions/it https://www.comune.napoli.it/flex/cm/pages/ServeAttachment.php/L/IT/D/1%252F9%252F2%252FD.e7456b9ad07748ac7a95/P/BLOB%3AID%3D37912/E/pdf
4	Rome	4.1 Resilience Strategy [Strategia di Resilienza].	https://www.comune.roma.it/web-resources/cms/documents/strategie-resilienza180618.pdf
		4.2 Action Plan for Sustainable Energy and Climate [Piano di Azione per l'Energia Sostenibile ed il Clima].	https://www.comune.roma.it/servizi2/deliberazioniAttiWeb/showPdfDoc?fun=deliberazioniAtti&par1=R0NE&par2=Mzc30A==
		4.3 Soil4Life Project—Guidelines for sustainable land use [Progetto Soil4Life—Linee guida volontarie per l'uso sostenibile del suolo per i professionisti dell'area tecnica].	https://soil4life.eu/documenti/
5	Turin	5.1 Climate Resilience Plan [Piano Resilienza Climatica].	http://www.comune.torino.it/torinosostenibile/
		5.2 Strategic Plan of Green Infrastructure [Piano strategico dell'infrastruttura verde].	http://www.comune.torino.it/torinosostenibile/
		5.3 'Valdocco Vivibile' Project [Progetto 'Valdocco Vivibile'].	http://www.comune.torino.it/verdepubblico/2020/altrenews20/progetto-valdocco-vivibile-nature-based-solutions.shtml https://www.torinovivibile.it
		5.4 DisastEr Risk Reduction InSurance (DERRIS) Project	https://www.torinovivibile.it/aree-tematiche/progetto-eu-life-derris/ http://www.derris.eu/il-cambiamento-climatico/ http://www.comune.torino.it/ambiente/cambiamenti_climatici/life_derris/index.shtml http://www.comune.torino.it/ambiente/bm~doc/derris-brochure-web-def.pdf

Table 4. Cont.

	City	Description	Source (Last Accessed: 15 June 2021)
6	Venezia	6.1 Preparatory plan: future climate [Piano preliminare: Clima futuro].	https://www.comune.venezia.it/sites/comune.venezia.it/files/documenti/Ambiente/2014_VENEZIA_CLIMA_FUTURO_mitigaz%20e%20adattamento.pdf https://www.comune.venezia.it/it/content/piano-clima-citt-venezia
		6.2 Action plan for sustainable energy [Piano di azione per l'energia sostenibile].	https://www.comune.venezia.it/sites/comune.venezia.it/files/page/files/PAES%202012%20con%20%20aggiornamenti%202020.pdf https://www.comune.venezia.it/sites/comune.venezia.it/files/page/files/PAES%202012%20con%20%20aggiornamenti%202020.pdf

4. Results

The cities considered adaptation to climate change in different ways. Up to May 2021, the SPPPs of Bologna, Milan, Rome, and Turin have shown more adaptation initiatives than those of Naples and Venice. In Table 5, we report the results of the scrutiny of the SPPPs according to the criteria in Table 1 and the scores decided in Table 2. With the purpose of summarizing a great variety of adaptation actions set in the documents, we clustered them according to the categories proposed in Noble et al. [39], who defined three general categories, i.e., “structural/physical”, “social”, and “institutional”, to organize adaptation options (see also the European Climate Adaptation Platform Climate-ADAPT [40]). As an example, the category “structural/physical” includes “structural and engineering options; the application of discrete technologies; the use of ecosystems and their services to serve adaptation needs; and the delivery of specific services at the national, regional, and local levels” (Noble et al. [39]). Structural and engineering options belong to the sub-category “Engineered and built environment” (Noble et al. [39]), which groups options such as coastal protection structures, water storage, improved drainage, building codes, transport and road infrastructure adaptation, etc. The reader is advised to refer to Noble et al. [39] (the document is available online free of charge) to acquire more details and practical examples of the adaptation options listed below.

Table 5. Results of the scrutiny of the SPPPs. Very dark blue is used when the criterion is explicitly fully met, soft yellow if it is implicitly—or partially—met, and white when the criterion is not met.

City	Strategies, Plans, Programs, and Projects	Assessment Criteria			
		Adaptation Strategy or Plan	Adaptation Objectives	Adaptation Measures	Climate Analysis
1	Bologna	1.1 BLUEAP	Very dark blue	Very dark blue	Very dark blue
		1.2 Action Plan for Sustainable Energy and Climate	Very dark blue	Very dark blue	Very dark blue
		1.3 Municipal master plan	Very dark blue	Very dark blue	Very dark blue
2	Milan	2.1 Municipal master plan	Very dark blue	Very dark blue	Very dark blue
		2.2 Air and Climate Plan	Very dark blue	Very dark blue	Very dark blue
		2.3 Clever Cities Project	Very dark blue	Very dark blue	Very dark blue
		2.4 ForestaMI Project	Soft yellow	Very dark blue	Very dark blue
		2.5 ClimaMI Project	Very dark blue	Very dark blue	Very dark blue
3	Naples	3.1 Action Plan for Sustainable Energy	Soft yellow	Very dark blue	Very dark blue
		3.2 Preparatory Municipal Urban Plan	Very dark blue	Very dark blue	Very dark blue
		3.3 Spatial Coordination Plan of the Metropolitan City	Soft yellow	Very dark blue	Very dark blue
		3.4 CLARITY project	Very dark blue	Very dark blue	Very dark blue
4	Rome	4.1 Resilience Strategy	Very dark blue	Very dark blue	Very dark blue
		4.2 Action Plan for Sustainable Energy and Climate	Soft yellow	Very dark blue	Very dark blue
		4.3 Soil4Life Project—Guidelines for sustainable land use	Soft yellow	Very dark blue	Very dark blue
5	Turin	5.1 Climate Resilience Plan	Very dark blue	Very dark blue	Very dark blue
		5.2 Strategic Plan of Green Infrastructure	Very dark blue	Very dark blue	Soft yellow
		5.3 'Valdocco Vivibile' Project	Very dark blue	Very dark blue	Soft yellow
		5.4 DisastEr Risk Reduction InSurance (DERRIS) Project	Very dark blue	Very dark blue	Very dark blue
6	Venezia	6.1 Preparatory plan: future climate	Very dark blue	Very dark blue	Soft yellow
		6.2 Action plan for sustainable energy	Soft yellow	Very dark blue	Very dark blue

As a general overview, it is possible to observe that the municipality of Bologna is committed to ACC, by focusing mostly on ecosystem services (generated by green areas, forestry, urban gardens), and technological and engineering options (permeable car parks, sustainable urban drainage). Other relevant actions concern government policies and programs (water management) and behavioral options (a risk alert system on social networks), including educational (awareness raising) and informational (early warning systems) options. As regards Milan, ACC efforts are mainly based on structural and physical ecosystem-based actions, institutional actions, such as government policies and programs, and social actions, such as educational options. Informational, technological, and structural and engineering options are also covered. The scrutiny of the tools for Naples showed adaptation efforts related mainly to options based on ecosystem services, technological, structural and engineering options, and informational actions. Rome is committed to ACC with respect mostly to ecosystem services, while an interest emerges in government policies and programs and behavioral, educational and informational, technological, and structural and engineering options. As for Turin, one of the strategic adaptation actions is the strengthening of the internal administrative technical competence regarding climate change. Other adaptation actions involve structural and physical options, such as engineering solutions, technological and ecosystem service-based options, and institutional actions, such as government policies and programs and economic options.

As for Venice, the analysis showed adaptation efforts related mainly to options based on ecosystem services, technology, structural and engineering approaches.

In Appendix A, we provide a more detailed picture of the results.

5. Discussion

The main results emerging from our scrutiny lead us to identify Bologna, Milan, and Turin as cities with a strong propensity towards the integration of ACC concepts. In fact, these cities have clearly promoted ACC in different sectors (local planning, energy, air, forests, and disaster risk reduction) and appear to have met nearly all of the assessment criteria introduced in Section 3.1. It is worth noting that Bologna and Turin have adopted an ACC plan, while Milan has not yet done so. However, Milan showed significant initiatives concerning ACC. This result may suggest a certain relevance of European, national, or regional adaptation policies, strategies, or plans as a framework for promoting and mainstreaming ACC in sub-regional contexts, which are devoid of local adaptation plans.

A clear reference to adaptation strategies is relevant to the mainstreaming of ACC, which is consistent with European or national guidance. Ledda et al. [20] remarked that “[...] mentioning the European and/or the national adaptation strategy in the regional tools could be considered the first step for introducing ACC considerations and principia in local plans”. Accordingly, the consideration of European or national ACC principles in the SPPPs should be interpreted as the willingness of policy makers to promote vertical coherence towards climate-resilient cities in operational terms. In other words, the strategic ACC principles can be better translated in specific ACC objectives/goals and measures undertaken by local communities, who know their own geographical context, characterized by particular environments, territories, landscapes, cultural backgrounds, and traditions. In this regard, the cities that have been able to introduce ACC principles into SPPPs are taking the first steps to protect their citizens from adverse effects due to climate change and/or are helping people benefit from a changing climate.

Most SPPPs set ACC objectives/goals. The definition of ACC objectives tailored to specific contexts could be considered the minimum requirement for designing ACC measures. As pointed out by Runhaar et al. [27], the integration of ACC objectives into plans could contribute to positively affecting the conservation of biodiversity and improving habitat quality, and may be relevant to the effectiveness of ACC actions. Clearly defined ACC objectives represent a framework for designing ACC actions that can contribute to successful adaptation although “[d]efining success simply in terms of the effectiveness of meeting objectives [...] is not sufficient [...]” [41], as successful actions may imply, among other things, negative externalities, i.e., an ACC action can increase negative effects “on others or reducing their capacity to adapt. [As remarked by Adger et al. [41], much] coastal planning for increased erosion rates, for example, involves engineering decisions that potentially impact neighbouring coastal areas through physical processes of energy dissipation and sediment transport” [41]. As pointed out by Serra et al. [22], at worst, “adaptation to climate change can trigger negative responses—maladaptation—[which] can imply unsustainable development”.

The tools of the six cities include ACC actions that encompass a wide range of solutions, such as an increase in green areas, awareness campaigns, insulation and greening in buildings, the improvement of thermal comfort in public transport, permeable parking and sustainable rain management, involvement of insurance companies in risk management, ecological networks with the identification of green and blue infrastructures, analysis and monitoring of local climatic variability, promotion of the use of green roofs and walls, bioswales, etc. The actions can be classified, according to the structural/physical, social, and institutional categories set in Noble et al. [39]. In the selected SPPPs, one of the most representative categories is ‘structural/physical’, which branches off into four sub-categories (more details in Noble et al. [39]), which includes a list of adaptation options. The most representative adaptation options mentioned in the SPPPs include: improved

drainage, green infrastructure, early warning systems, adaptive land use management, and building insulation.

The SPPPs included explicit adaptation measures set according to specific aims, geographical location, and urban characteristics. Setting ACC actions according to a specific context is essential, as ACC actions that are effective in a given context can be totally ineffective in another [7,42]. In other words, specific ACC actions are less exportable in different contexts than mitigation actions, such as the reduction in GHG emissions into the atmosphere [42]. The role of local communities and administrations is evident for designing adequate actions that meet the specific needs of ACC. Some SPPPs are devoid of—or do not refer to—any climate analysis (e.g., Clever Cities Project). Thus, it is unclear whether proper adaptation actions have been designed where explicit reference to climate analysis is missing. We did not investigate further to clarify this issue, and this is a limitation of this study. In some SPPPs (e.g., the Municipal master plan of Bologna and the Preparatory Municipal Urban Plan of Naples), we identified implicit ACC actions, i.e., “implicit measures, which have not been defined as a response to climate change, but are useful for adaptation” [7], in addition to the explicit ones. This is relevant to ACC, as implicit actions could be entry points for explicit actions [7,42,43].

Some of the SPPPs include—or refer to—climate analysis, and some of them refer to climate projections using the Representative Concentration Pathways (RCPs) IPCC scenarios. The RCPs were used as a baseline tool in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [44]. There are four RCPs, ranging from very high (RCP8.5) through to very low (RCP2.6) future atmospheric greenhouse gas concentrations. The values of the RCPs (2.6, 4.5, 6.0 and 8.5) refer to the radiative forcing in 2100. It is crucial working with RCP scenarios “to better understand uncertainties and alternative futures, in order to consider how robust different decisions or options may be under a wide range of possible futures” [45]. RCPs are thus intended to encourage people to shape the future they want rather than select from a set of predetermined futures [46]. A climate analysis, which includes both observations of the past climate and future climate scenarios, should be the basis for defining ACC strategies and actions [20]. However, Nissan et al. [47] pointed out that the use of climate model projections has practical limitations in local decision-making contexts, which include climate model errors, regional downscaling, deep uncertainty, and natural variability (more details in Nissan et al. [47]). One of the critical issues in some of the SPPPs regards the unclear reference to climate analysis: as an example, the Clever Cities Project (Milan) and the Resilience Strategy of Rome lack any reference to past climate observations and future climate scenarios. Therefore, further research needs to clarify the reasons behind these weaknesses.

6. Conclusions

In this study, we answered two research questions (RQs). For RQ1, we applied a methodological approach able to provide an overview of the integration of adaptation to climate change (ACC) considerations at the sub-regional scale in planning tools adopted by six Italian cities, i.e., Bologna, Milan, Naples, Rome, Turin, and Venice. The assessment criteria applied to scrutinize the strategies, plans, programs, and projects (SPPPs) consisted of (i) references to ACC strategies (from international to regional scale), the inclusion of ACC (ii) objectives and (iii) measures, and (iv) references to or the inclusion of climate analysis on historical series and/or future projections. The criteria have proved to be useful for scrutinizing SPPPs adopted in recent years by the cities.

As regards RQ2, we found out that the SPPPs have included adaptation to climate change (ACC) in a promising way. The SPPPs of Bologna, Milan, and Turin show more consideration of ACC than the SPPPs of the other cities. The three cities have clearly promoted ACC in the adopted tools in sectors such as local planning, energy, air, forests, and disaster risk reduction: most SPPPs have met nearly all the assessment criteria.

We feel that this study can contribute to the advancement of the research in two ways. Firstly, we proved that the four basic assessment criteria provide policy makers

and planners with a first clear overview of strengths and weaknesses of SPPPs that affect citizens, settlements, and infrastructures. In other words, tools that appear to be lacking in key ACC contents can be subjected to updating processes, which are necessary to include principles and measures for promoting resilience in practice, at an operational level, i.e., at municipal scale. Secondly, the best-performing tools scrutinized in this study can be used by other municipal institutions to learn the best ACC practices.

The main limitations of this study refer to (i) the relatively small sample of cities considered, although the selected cities are among the most relevant as resident population, and (ii) the few basic criteria applied to assess the SPPPs while some other additional criteria could be used. In future research, we will scrutinize additional SPPPs adopted in other cities and expand the set of assessment criteria by considering, for example, whether those responsible for the implementation (and monitoring indicators) of ACC actions are clearly identified in the SPPPs.

As a concluding remark, we stress that the methodological approach adopted in this study has been usefully applied in practice in the context of a research project, whose findings are freely available online [48].

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Appendix A

Below we provide a more detailed picture of the results.

Appendix A.1 Bologna

We scrutinized three tools: the Bologna Local Urban Environment Adaptation Plan for a Resilient City, Action Plan for Sustainable Energy and Climate, and Municipal master plan. These tools clearly meet all of the criteria. The plans refer to adaptation strategies, such as the EU adaptation strategy and/or the national adaptation strategy. The plans consider extreme temperature and precipitation (heavy precipitation and no precipitation). While the Bologna Local Urban Environment Adaptation Plan for a Resilient City has three general objectives for combating the three main vulnerabilities (drought and water scarcity, heat waves, extreme rainfall and hydrogeological risk) and specific objectives for each vulnerability, the Action Plan for Sustainable Energy and Climate includes adaptation objectives, in terms of increasing public green spaces, the promotion of sustainable drainage systems and natural solutions, reducing domestic and non-domestic water consumption, and improvement of the quality of surface waters. The Municipal master plan includes three main objectives, i.e., making the city more resilient, habitable, and attractive. The

adaptation measures of the three plans mainly consist of structural and physical measures, and all of the plans include climate analysis. The city of Bologna has promoted initiatives relating to climate change, which are disseminated through websites such as chiara.eco.

Appendix A.2 Milan

We analyzed five tools: the Municipal master plan, Air and Climate Plan, Clever Cities Project, ForestaMI Project, and ClimaMI Project. The plans refer to adaptation strategies such as the EU adaptation strategy and/or the national adaptation strategy, or to other documents, which recall adaptation strategies. The tools focus on extreme temperature and precipitation (heavy precipitation and no precipitation). In terms of adaptation objectives, the Air and Climate Plan aims at improving the environmental quality and adaptability of the city, while the Municipal master plan aims at achieving a healthy and resilient urban environment, and implementing and monitoring the process of ACC. The Clever Cities Project promotes sustainable and socially inclusive urban regeneration, the inclusion of nature-based solutions in urban planning processes, and the monitoring and evaluation of the implemented adaptation measures. The ClimaMI Project aims at defining an urban climatology, setting indicators for designing meteoric drainage works in urban areas, retrieving and evaluating climatic data available for Milan, etc. Finally, the ForestaMI Project focuses on the increase in urban green areas, planting trees in the Metropolitan City by 2030, reducing pollution, etc. The most common adaptation measures mainly consist of structural and physical (for example, the redevelopment of the municipal building heritage, experimentation with innovative green roofs and walls in private and/or public buildings), institutional (working tables with supra-municipal bodies for the development of sustainable agriculture and animal husbandry), and social (participation of citizens in the maintenance of green areas) measures. The Municipal master plan, the Air and Climate Plan, and the ClimaMI Project explicitly refer to climate analysis. The city of Milan has adopted guidelines for the design of sustainable urban drainage systems in the municipal area, which aim to support the design of infrastructures for urban rainwater drainage.

Appendix A.3 Naples

We considered four tools: the Action Plan for Sustainable Energy, Preparatory Municipal Urban Plan, Spatial Coordination Plan of the Metropolitan City, and the CLARITY project. Only the CLARITY project explicitly refers to the EU adaptation strategy. The tools consider extreme temperature and precipitation (heavy precipitation). As regards the adaptation objectives, the Action Plan for Sustainable Energy aims at increasing the climatic resilience of the territory and the population, with specific focus on extreme temperature and expected precipitation. The Spatial Coordination Plan of the Metropolitan City focuses on an efficient use of water resources. The Preparatory Municipal Urban Plan promotes the regeneration of environment and ecosystems, the protection of biodiversity, and increasing resilience. The CLARITY project aims at supporting planners and policy makers to easily identify and mitigate risks associated with climate change through the development of climate services to facilitate the integration of adaptation measures into urban regeneration actions. The structural and physical measures (green and blue infrastructure, urban forestation of large paved areas, bioswales, etc.) are the most representative of the scrutinized tools. As for the climate analysis, the Action Plan for Sustainable Energy includes references to climate change scenarios for the Municipality of Naples, while the Preparatory Municipal Urban Plan includes a detailed analysis of extreme weather events related to climate change, referring to heat waves and precipitation. The Spatial Coordination Plan of the Metropolitan City addresses some aspects of the climate analysis, which are of interest for adaptation. Currently (February–March 2021), Naples has not adopted a strategy or plan on ACC. The Municipality is a partner in the CLARITY Project for the adaptation of cities to climate change. Naples is starting to embed adaptation approaches to climate change into key tools that regulate the development of populations and territories.

Appendix A.4 Rome

We examined three tools: the Resilience Strategy, Action Plan for Sustainable Energy and Climate, and the Soil4Life Project—Guidelines for sustainable land use. The Action Plan for Sustainable Energy and Climate refers to the National Strategy for Adaptation to Climate Change, while the other two tools do not refer to national or European adaptation strategies. The tools focus on extreme temperature and precipitation (heavy precipitation and no precipitation). The adaptation objectives of the three tools are described as follows. The Resilience Strategy aims to (i) assess the effects of climate change and promote greater awareness among citizens and (ii) implement green and blue infrastructures for the mitigation of urban heat islands and infrastructures and pilot projects to mitigate the risk of flooding. The Action Plan for Sustainable Energy and Climate aims to increase the resilience of the territory and population, with specific focus on extreme temperature and expected precipitation. The Guidelines for sustainable land use (Soil4Life Project) aim to provide guidance for the sustainable management and climate resilience of soils. All of the tools set out adaptation measures that consist of structural and physical measures (ecosystem-based adaptation options), and most of them also consider social measures (awareness campaigns, specific meetings and practical exercises on the expected risks). The Action Plan for Sustainable Energy and Climate is the only tool that refers to climate analysis for climate risk assessment. The Soil4Life project is part of the climate change adaptation actions envisaged by the Action Plan for Sustainable Energy and Climate of Rome. Furthermore, “Roma Capitale is responsible of the pilot action ‘reduction of waterproofing in the Roma Capitale area’: the objective of the action is to propose possible operational and long-term solutions aimed at counteracting increasing waterproofing of soils through specific governance actions. As part of the pilot action, the ‘Soil Permeability Map of the Municipality of Rome’ was developed [which is] a high-resolution mapping of the entire municipal territory with three main focuses on highly impermeable areas, areas with high criticality and natural areas, as well as the identification of the factors that limit, prevent and/or reduce soil permeability. The activities envisaged as part of this action will lead to the drafting of a Municipal Plan for Soil Permeability, which includes a series of interventions that the Municipal Administration will undertake to implement to reduce the problem of soil waterproofing [. . .]. The soil permeability map, one of the project outputs, was prepared based on the superimposition of maps and on a systematic collection of information on the state of the soil in the territory of Roma Capitale, by using data collected over the years by both Technical Offices of the Municipal Administration, Universities, and Research Institutes” (personal communication [49]). As for Rome, we also mention the ‘RU:RBAN’ project, which focused on urban agriculture and has a role in terms of ACC. As reported by the Communication Manager of the project: “Urban Agriculture prevents and reduces land consumption as the areas intended for urban gardens are neither built nor waterproofed. Urban vegetable gardens prevent soil consumption and contribute to the reduction of instability phenomena and to the reduction of the heat island phenomenon [the project indirectly refers to strategies and/or adaptation plans], as it reduces the distances in the agro-food chain, consequently reducing the emissions due to transport. In addition, urban vegetable gardens play an important educational function towards reducing food waste” (personal communication [50]).

Appendix A.5 Turin

We considered four tools: the Climate Resilience Plan, Strategic Green Infrastructure Plan, ‘Valdocco Vivibile’ Project, and the DisastEr Risk Reduction InSurance (DERRIS) Project. The Climate Resilience Plan and the DERRIS Project refer to the EU adaptation strategy, while the Strategic Green Infrastructure Plan refers to the Climate Resilience Plan. The tools focus on extreme temperature and precipitation (heavy precipitation), and the DERRIS Project also considers the typhoons. The Strategic Green Infrastructure Plan aims at increasing the quantity and quality of green areas in the city and developing green infrastructures especially in areas with greater climate vulnerability. The Climate Resilience

Plan aims to lessen the impacts resulting from climate change by reducing the occurrence of critical phenomena and increasing the ability to manage emergencies. The DERRIS Project aims at increasing the resilience of small and medium-sized enterprises to the risks deriving from environmental disasters linked to climate change, such as floods, landslides, droughts, and typhoons. The ‘Valdocco Vivibile’ Project aims to increase the use of green infrastructures to mitigate the effects of the urban heat island effect and manage rainwater. Most tools set out adaptation measures that consist of structural and physical measures (engineering and built environment options and ecosystem-based adaptation options), and most of them also consider social measures (awareness raising). The Climate Resilience Plan and the DERRIS Project explicitly refer to climate analysis. The city of Turin archived documents on sustainability and resilience on an ad hoc webpage: ‘Sustainable Turin 2030 | Resilient’ (<http://www.comune.torino.it/torinosostenibile/>, accessed on 15 June 2021). The city of Turin has recently created a new website (June 2021), which is structured by thematic area, including climate change. In this regard, initiatives related to ACC are archived in a thematic area called ‘Climate Resilience Plan’ and ‘Action Plan for Energy and Climate’. Actions and projects that may have a role in terms of ACC are also referred to, including: ‘Evaluation of public green ecosystem services’, ‘Urban forestry’, ‘GE.MI.TO Protocol’, ‘Valdocco Vivibile’ and the ‘EU LIFE DERRIS Project’.

Appendix A.6 Venice

We scrutinize two tools: the Preparatory plan-future climate, and the Action plan for sustainable energy. Both tools focus on extreme meteorological events. The Preparatory plan-future climate aims at the enhancement of natural green areas and the improvement of the permeability characteristics of the soil, aimed at reducing hydrogeological risk. The Action plan for sustainable energy includes objectives aimed at addressing extreme meteorological events. The tools include both structural and physical and social adaptation measures, refer to climate analysis, but do not refer to the EU adaptation strategy. Since 1980, the Tide Forecast and Information Centre of Venice has been providing adaptation tools for the population; as an example, it provides accurate tide forecasts and discloses them on its website and through an official app. In addition, there are several initiatives that encourage sustainable mobility.

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